INSTITUTE OF PETROLEUM REVIEW

OL 7. No. 81. SEPTEMBER, 1953. Price 1/6d. Annual Subscription: Fifteen Shillings

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No. 81 SEPTEMBER 1953 Vol. 7

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THE PERSIAN GULF*

By P. M. de VEULLE

The rise of new oil producing and refining areas in the Persian Gulf within the past few years has done much more than change the pattern of the international oil industry. It has brought swift and startling change of an unprecedented character and scale to territories hitherto hardly touched by modern ideas and modern things. To most people outside the Arab world, Kuwait, Saudi Arabia, Bahrein, Qatar, and the Trucial Coast, seemed, until a short time ago, remote, unknown, and slumbering lands, as indeed they were. Quickly, the scene has changed. Their traditional patriarchal form of theocratic governance remains but, suddenly, an avalanche of oil wealth has brought within their grasp blessings and benefits unimaginable only a few years ago. Close relationships of a novel kind have been created with the West. About 50,000 people of all categories are now working in the newly established local oil industries and the livelihood of many thousands more is indirectly dependent upon oil. Traditional Arab contempt for manual work is diminishing. The irresistible influences of western technology are at work. Advances which elsewhere have only been achieved after generations or centuries of struggle and change, have become possible almost overnight. In a wider field too, these countries, as repositories of immense oil resources, and their neighbours who are potential oil-

*An address to the Oil Industries Club, reproduced by courtesy of *Petroleum Press Service*.

producing lands, have quickly acquired a new significance both in the Middle East and in the field of international affairs—a significance heightened by the events in Persia and by the imperatives of the cold war.

What is happening in Saudi Arabia and Kuwait has never happened before either in the world of oil, or in the realm of social and economic change. The pace of oil development has been phenomenal. Production in Saudi Arabia began in 1938, but had only reached one million metric tons in 1944. By 1947 it had leaped to 12 million tons and to 26 million tons by 1950. Helping to make good the loss of Persian supplies, output again leapt forward to 37 million tons in 1951 and to 41 million tons in 1952, reaching in June a peak rate equivalent to about 43 million tons a year.

The development of Kuwait has been no less remarkable. Production began only in 1946 but reached over 17 million tons in 1950, rising to 28 million tons in 1951 and to over 37 million tons in 1952 with a peak rate equivalent to about 41 million tons a year in mid-year. With their combined

MIDDLE EAST OIL PRODUCTION, 1946-52
(Thousand Metric Tons)

	1946	1949	1950	1951	1952
Persian Gulf					
Kuwait	800	12,378	17,291	28,226	37,637
Saudi Arabia	8,200	23,471	26,179	37,200	41,443
Bahrein	1,100	1,512	1,512	1,509	1,500
Qatar	—	96	1,632	2,369	3,297
Total	10,100	37,457	46,614	69,304	83,877
Other M.E. Countries					
Persia	19,479	27,235	32,258	16,838	1,000
Iraq	4,607	4,068	6,480	8,630	19,000
Egypt	1,282	2,280	2,340	2,333	2,400
Grand Total	35,468	71,040	87,692	97,105	106,277

production of 79 million tons last year these two territories alone provided about one-third both of the oil production of the free world excluding the U.S.A. and of the crude oil tonnage entering international trade. Together they produced nearly as much as Venezuela did in the previous year. They remain a good distance ahead of Iraq, soon destined to reach an output of 30 million tons a year. Still relatively small but potentially important, the peninsula of Qatar, where production began only three and a half years ago, is moving towards an annual output of about 4 million tons a year. The island of Bahrein's crude oil output is likely to remain at the present level of 1½ million tons a year where it has stood for some years past.

The remarkable growth of oil production in the Persian Gulf would in itself have been of far-reaching local importance. But it has been accompanied by a marked upward revision of the oil revenues to be received. During 1951 and 1952, 50-50 profit-sharing agreements were made with all the respective concessionaires which brought still more—considerably more—income from oil production. While the Indian rupee is the currency in day-to-day use in Kuwait, Bahrein, and Qatar, their oil revenues are now paid in sterling instead of, as formerly, in rupees. Saudi Arabia's oil revenue is paid partly in dollars or sterling and partly in the various foreign currencies received from oil importing countries. Also, to an increasing extent, the food, stores and equipment needed by the oil company (Aramco) in Saudi Arabia are procured with non-dollar currencies received for oil exports.

The marked expansion of crude oil production in the Persian Gulf—as indeed in Iraq and earlier in Persia—rests, of course, upon the remarkable size and prolificity of most of the oil-bearing structures so far found in the region. Nowhere else have such favourable underground conditions been encountered, and the granting of concessions over large areas has ensured that the maximum advantage is reaped. The Persian Gulf region is, however, by no means fully surveyed or explored for oil. Very large areas of the Arabian Peninsula still have to be tested and there is no reason to suppose that the notable

degree of success thus far enjoyed will mark the peak of achievement. Indeed, revaluations, new knowledge gained, and the latest exploration successes in Kuwait and Saudi Arabia show that even recent expectations and estimates of potentialities have been too low. All this is the more striking in that up to 20 years ago it was almost an article of faith among oilmen that there was no oil in Arabia.

Despite the difficult natural conditions encountered in arid desert lands, the basic operations of discovering and producing oil themselves present the least of the problems in the region. The maintenance of good relations between the concessionary company and the local government is obviously a primary necessity. The sudden large influx of wealth that has followed both from higher production and the coincidental introduction of 50-50 profit-sharing agreements creates its own problems which, however, would be no less should there be any decline in production and revenues.

The first-class health and medical facilities provided by the oil companies are a major contribution to local welfare, as are the technical training and education given to local labour. These and, for example, the importation of foreign skilled labour, are matters of direct concern to local governments. But the biggest ancillary task which the oil companies in this region have to face is the necessity of themselves having to create locally, or to import literally from all corners of the earth, virtually all the necessities of life for their imported staff and skilled labour, as well as practically all the equipment and stores needed for their operations.

In all the territories, the oil companies have encouraged, with some notable successes, and despite considerable difficulties, local businesses to cater for some of the companies' varied needs. Thus, in addition to the very large wages funds distributed by the companies and the oil revenues spent by the governments, considerable sums of money regularly enter the stream of circulation through the growing number of contractors—some local, and some from Middle East and other countries—and local traders serving the oil companies.

Kuwait

Almost everything that is associated with oil development in the sparsely populated lands of the Arabian Peninsula brings new ideas and changes, which may amount to a revolution in ways of life for nearly all who come within the orbit of the oil companies' operations. Nowhere else in the world is there any parallel with the situation in Kuwait where a small old-established 2000-sq. mile desert state, whose population even when inflated by current developments numbers no more than about 150,000 people, now enjoys oil revenue of some £60 million a year in contrast to an insignificant total revenue only a few years ago.

This income is more than even the widespread welfare facilities and the grandiose plans for general development now being carried out or contemplated can absorb. The town of Kuwait, where half or more of the population lives, is being rebuilt and modernized, involving an annual expenditure of £15 million for at least 10 years. Water, hitherto scarce, is being provided from the distillation of seawater using waste natural gas as fuel. The most up-to-date buildings are being built for hospitals and schools, and it is hoped in due course to attract to Kuwait students from other parts of the Middle East. Many large modern houses have recently been built, and in the future lies the construction of a sewage system and the much-needed rehousing of the town-dwellers now subjected to very high rents owing to the shortage of houses. Among proposals for diversifying the economy are the

improvement of docks and of the local ship-building facilities to help encourage trading around the shores of the Indian Ocean where Kuwaiti dhows have long been a feature, and of local brick building and glass-making. Research is also proposed into the prospects of desert agriculture aided by the money now available for providing the needed water supplies. With all this, and with a building boom in full swing, has come a great increase in the profits of local traders, agents, and contractors, the latter usually working in association with U.K. firms.

But, thanks partly to abundant supplies and competition in the local market and to the relatively low level of personal needs and expenditure, this influx of wealth and the greater volume and intensified circulation of money has not brought any marked degree of general inflation. Land values in and near the town have, however, soared.

Kuwait remains a patriarchal state, with the Sheikh, aided by other hereditary governing families, personally guiding its affairs and easily accessible to his people. Although Kuwait has no adviser in the sense that advisers serve the rulers of Bahrein and Qatar, the ruler has engaged a number of British staff who carry out the day-to-day administration of finance, state development works, and other tasks. Unlike Saudi Arabia and Bahrein, there is no published budget. In the light of the greatly expanded total revenue and of the heavy family and charity calls which are traditionally made upon him, the privy purse of the ruler—a scholarly, simple-living, and modest man—receives only a very small proportion. But even with all the capital works now in progress and with the much higher cost of state administration—which will continue to rise for many years to come as new welfare facilities are created—there is likely to be a considerable surplus of revenue over expenditure, which cannot be absorbed by such a small and naturally restricted economy. Wisely, the Sheikh and his advisers foresee that the level of oil profits may not always remain as satisfactory as they have been in recent years. An investment board has therefore recently been set up in London to invest part of the oil revenues not only as provision for a rainy day, but against the time when the oil resources will, as they must eventually, be exhausted.

This prospect is, however, rendered more remote by recent developments. Additional to the Burgan field with its unique characteristics, Kuwait Oil Co.—jointly owned by Gulf Oil and Anglo-Iranian—has now begun production from the new Magwa field, north of Burgan. The extent of this field is still being delimited, but present potential is at least 250,000 b.d. The crude oil is similar to that from Burgan. A further structure has also recently been discovered on the Ahmadi ridge which lies between Burgan and Magwa, the discovery well producing at 2000 b.d. These three areas are only a few miles from the coast, but the company's concession covers all the state also territorial waters for a distance of six nautical miles, and there are possibilities of finding oil further inland; the frontier with Iraq is now being demarcated. A promising discovery has recently been made in the Neutral Zone over the mineral resources of which Kuwait and Saudi Arabia have equal rights. Refining, hitherto relatively unimportant in Kuwait, is now to be expanded, and the capacity of Kuwait Oil Co.'s plant at Mena al-Ahmadi is to be raised from about 1½ million tons a year to about 5 million tons by the end of next year.

Already there is enough oilfield gas going to waste to meet all Kuwait's likely future needs. Thus in addition to great money resources for capital development and for current expenditure, Kuwait enjoys the assurance of abundant supplies of very cheap and efficient fuel for operating whatever

utilities or industries it may create. It is not too much to say that no other community in the world has been so suddenly favoured as this one. Great wisdom is needed in using what, for such a small community, is literally fabulous wealth.

Saudi Arabia

Except in respect of its abundance of oil and its equally high level of oil production and revenue, the setting in Saudi Arabia bears little similarity to that in Kuwait. Finally unified by the sword by the present remarkable ruler, King Ibn Saud, only about 30 years ago, it stretches over a desert area of over 900,000 sq. miles with a widely scattered population estimated at from five to seven million. So far, all oil development has been in the Hasa province along the Persian Gulf, and carried out by Aramco, a wholly U.S. company comprising Texas, Standard of California, Jersey Standard, and Socony and by whom no British supervisory staff may be employed. The country is ruled by an absolute theocratic monarchy inspired by the puritanical Wahhabi code. Nevertheless, many of the good things that the West offers find an avid welcome. There are marked contrasts, not only between the rich and poor, but between the new and old.

Slowly, the administrative machinery which the use of the country's newly found oil wealth imposes is being evolved, but geography, distance, and natural inertia are always formidable obstacles. There is no local paper currency, and new Saudi Arabian gold coins have recently been introduced into circulation. Until recently there were no official local rates of exchange for the several foreign currencies in which the country now receives its oil revenues. The establishment of suitable exchange rates was one of the main purposes for the establishment last year of the non-profit Saudi Arabian Monetary Agency, with headquarters at Jeddah. The

Agency has a Board of local directors and an American as its governor and chief executive officer. It also serves as a central body for budgetary control, for issuing and controlling currency, and performing many of the functions of a modern Treasury, including the provision of financial and economic information to the Government to aid it in formulating and executing its financial and economic policies. It is intended also, that the Agency should hold reserves both to strengthen the currency and also as security against any future decline of oil income.

In the budget estimates for the year ended March 1953 direct oil revenues were Riyals 570 million, equivalent to about £59 million (Riyals 9·65 : £) out of the country's total revenue of about R. 700 million. The next most important item of revenue was customs duties, estimated to yield R. 70 million, much of this revenue resulting from the expansion that accompanies oil developments. Gold mining, the only other extractive industry, yielded the state a revenue of only R. 600,000.

Although revenue is now about 30 times larger than it was in 1940, and compares with the equivalent of £21·5 million in 1947 and £49 million in the previous year, budget estimated expenditure for the year ended in March

1953 exceeded revenue by R. 26 million, or about £2·6 million. Priority is given to expenditure on the armed forces which it is intended should be fully modernized. Including constructional work, they absorb R. 135 million which contrasts with allocations during the year of R. 23 million for water improvements, 29 million for the newly formed Ministry of Health, 13 million for education, and about 4 million for agriculture in respect of which there has been considerable expenditure in previous years. R. 19 million is also provided for the police. Over R. 150 million of expenditure is absorbed by the town and royal settlement at Riyadh, capital of the Najd, comprising R. 36 million for the very large Royal family with its many claimants upon its bounty, R. 66 million for the cost of administration in Riyadh, and R. 50 million for payment to tribes and irregulars. Mosques and generous provision for meeting the needs of pilgrims to Mecca and improving facilities for the pilgrimage absorb at least R. 28 million. R. 55 million is allocated for the Hejaz railway, and R. 10 million for the further provision of airports, while R. 100 million is devoted to the reduction of debt which is now very small. The absence of any fiduciary issue of currency means that any increase in coinage in circulation involves a claim upon current revenue which in the past budget was R. 30 million.

Lavish spending at the centre has been a feature in recent years, and with sharply rising oil revenues this could hardly be expected to diminish. The introduction of independent executive responsibility for handling the finances of the country is a particularly welcome advance, and serious efforts are also being made to improve provincial and local administration. There are, however, many physical difficulties, local rivalries, and centuries of stagnation to overcome. Not the least problem is the shortage of efficient and modern-trained officials. Some assistance in this respect is being received by the engagement of advisers from some other Middle East countries. With suitable training and guidance the Saudi Arabs, like the Arabs in other areas, readily absorb modern techniques and skills; but no less essential for bringing about the many general improvements which the rulers wish to see is the right kind of administrative setting which will ensure that plans are properly carried out.

The wider geographical spread of field operations in Saudi Arabia makes production there more expensive than in Kuwait. The established oil reserves are abundant, even super-abundant. The most recent development has been the establishment of the vast Ghawar field, at least 100 kilometres in length and up to 35 kilometres in breadth, constituting the linking together of the former separate and already large fields of Ain Dar and Uthmaniya. The Ghawar field may stretch still farther south, and be the largest field of any in the Middle East. There are still vast areas to be explored within Aramco's concession area which originally covered 440,000 sq. miles. Exploration work extends into the almost legendary Rub' al Khali, or Empty Quarter, where an American geophysical team of about 50 has recently been working over a considerable area and where it is intended to drill a deep test later this year. Owing to the possibility of finding oil in the south and south-east of the Arabian peninsula there are now some difficult frontier disputes to be settled in the region.

In the Hasa province itself, where all Aramco's producing and refining activities are carried out, there has naturally been a great expansion of the general economy, including the creation of a new port, new towns, airfield, roads, and the building of the 357-mile railway from Dammam to Riyadh. But there has also been considerable development in the Hejaz. A feature of all this

new activity has been the rise of local building and other contractors to whom Aramco has given great encouragement. There is no lack of enterprise among the trading community now being enlarged by the creation of a small but wealthy property-owning business class.

Bahrein

The 210-sq. mile island of Bahrein, with its 110,000 people, is the best governed, the most advanced, and the most stable of the Persian Gulf areas. Both the oilfield and refinery are operated by Bahrein Petroleum Co. (Texas and Standard of California), but most of the staff are British. The steadiness of its relatively small oil production and the important wages value of the local refinery (throughput about 9 million tons a year) have brought a healthy local prosperity, while oil developments elsewhere in the Persian Gulf have enhanced its traditional role as a trading and communications centre, without, however, imposing the strains of sudden boom.

Under wise and competent government—thanks largely to the devoted service over many years of a British adviser—the people enjoy the advantages of being a small compact community and many of the facilities of the welfare state. Direct efforts are continually made by the Government to check tendencies towards higher costs of living and the people are enjoying steadily rising standards. Good progress is being made in replacing in the towns the primitive barasti (palm branch) house by modern stone-built houses, but as elsewhere in the region where development has occurred, land values have risen sharply bringing a great accretion of nominal wealth to the owners, but constituting an irrational element in, and an obstacle to, social development. Prices in general, and the wage level, in Bahrein have risen less than in other Gulf areas and there is a drift of clerical and manual workers to

adjacent oil territories, which, however, is to some extent made good by an influx into Bahrein from the Trucial Coast.

Bahrein publishes an annual budget and accounts both of the central government and of municipalities; in the case of Manama, the capital, the municipality is composed partly of elected representatives of householders, which is itself a unique political advance within the Persian Gulf. Under the new 50-50 agreement which came into force from January 1, 1952, oil revenues to the State will be about £2¼ million a year, comparing with customs receipts—the second item in order of importance in the budget—which are equivalent to about £500,000. The new scale of oil revenue means that within two or three years Bahrein's total revenue will have been virtually doubled and stand at about £3 million a year. In the past, one-third of the oil revenue, then smaller than at present, has been for the ruling family with its many obligations. The budget estimates for the year ended October 1952 (which included provisional payments in anticipation of the retrospective 50-50 agreement concluded at the end of 1952) show that approximately a third of the estimated

oil revenues were to be spent locally and a third invested.

Qater and the Trucial Coast

Qatar presents yet another different picture. Arid, with a declining population of no more than 20,000, its Dukhan oilfield (operated by an associate of Iraq Petroleum Co.) has large reserves and is now producing at the rate of about 3½ million tons a year, the present 75-mile, 12-inch pipeline across the peninsula having a capacity of about 4½ million tons a year. From a bare subsistence until only three years ago, this small state is now receiving oil revenue under last year's 50-50 agreement of about £5 million a year. Hitherto, about a quarter of the oil revenues has been reserved to the Sheikh's Privy Purse, upon which, as is common in the region, many calls for local charity are made.

With the help of a British adviser, doctor, and engineers, public utilities and other modern amenities are to be provided in the capital of Doha where half or more of the population lives, and much new building is taking place. But beyond this and the maintenance of welfare services for the small population there is little possibility of fruitfully spending future oil revenue locally.

Oil exploration is continuing on the peninsula, although a recent deep test well proved to be dry. A fresh survey of the 10,000 sq. mile under-water concession off the coasts of Qatar is now beginning. The prospects are for higher oil production, and if oil prices and profits hold, for still higher revenues, which it will not be possible to absorb fully locally.

New Horizons

I.P.C. interests are searching for oil in other states of the Trucial Coast, so far, without success. Exploration is handicapped in some areas by land frontier disputes with Saudi Arabia, but also between these territories themselves who, nevertheless, have made claims upon the under-sea areas off their coasts.

On the Move

The greatly heightened oil activity in the Persian Gulf area in the past few years has been accompanied by a considerable movement of peoples within, and into, the region. Bedouin, whose families have roamed the desert for centuries, have abandoned nomadic ways and eagerly seek to become oil workers. They show a surprising aptitude for acquiring crafts and skills, and a great desire to learn. The clock, the motor vehicle, the radio, and the aeroplane have quickly become familiar objects invoking, however, but little sense of wonder since there is no understanding of the achievements that lie behind them. A considerable number of skilled Indian and Pakistani craftsmen have been attracted to the oil areas where they earn more than they could in their homeland. There are also various categories of Italian, Lebanese, Egyptian, Palestinian Arab, and workers from other Middle East countries with, however, Persians notably absent from all the areas.

Air travel and means of communications are commonplace and indispensable. Rulers travel overseas and receive other rulers, while increasing numbers of traders, students, and others visit other lands. While illiteracy among adults is still general and it is only in Bahrein that a vernacular uncensored press exists and public cinema shows are allowed, radio programmes from Middle East and other centres are widely listened to, making more appeal than the repetitive religious broadcasting from local stations. Newspapers from other Middle East countries are also read. The local rulers enforce a strict prohibition of sale to, or the consumption of liquor by, Arabs, and everywhere in the Persian Gulf women are still in purdah, but with the spread of education for girls as well as boys in both Bahrein

and Kuwait, and the other emancipating influences, the casting of the veil in the more rapidly advancing areas can only be a matter of time. Indeed, in every respect new ideas and new influences are at work and rapid change is taking place which, if deplored by some, it must be said that no-one seriously seeks to halt or hinder.

The areas where oil developments have occurred are, of course, only oases of prosperity, amid the poverty and distress in the Middle East. Unhappily there is as yet no likelihood that money surplus to the needs of one country can be made available to help other less fortunate countries in the region as a whole. The Persian Gulf oil States are still far from having the sharp political consciousness found in some other Middle East countries, and in this sense they lie apart from them. They have their own rivalries but are unaffected by the xenophobia that afflicts Persia nor by the suicidal policy of Dr Mossadeq, except to observe its failure.

If there are no precedents to guide in meeting the novel situation in these States there are plenty of examples of the dangers of excessive wealth, which are not least when the wealth is suddenly acquired. And the oil importing countries have a close interest in the wise handling of the Persian Gulf's newly found prosperity. The first major task is to seek to ensure long-term economic stability in the oil producing countries by the good use and careful husbanding of the present high oil revenues which, under the 50-50 agreements, are subject to the fluctuations of the world oil market which itself may be influenced by the Middle East's own abundance of oil. These revenues are also subject to local inflationary tendencies and rising local costs as well as to the impact of developments which may occur in respect of new or alternative forms of energy. The second major task is gradually to bring about suitable administrative mechanisms and reforms so as to meet the needs of changing societies subject to all the dangers of a too rapid change, and yet to satisfy the wants of newly awakened peoples.

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ASTM STANDARDS

At the 1953 Annual Meeting of the ASTM a considerable number of new specifications and test methods were approved, including the following:

Effect of grease on copper (D 1261-53 T).
Lead in new and used greases (D 1262-53 T).
Leakage tendencies of automotive wheel bearing grease (D 1263-53 T).
Water washout characteristics of lubricating greases (D 1264-53 T).
Sampling liquefied petroleum gas (D 1265-53 T).
Sulphur in petroleum products and liquefied petroleum gases by the Co_2-O_2 lamp method (D 1266-53 T).
Vapour pressure of liquefied petroleum gas (D 1267-53 T).
Unsaturated light hydrocarbons (silver-mercuric nitrate absorption) (D 1268-53 T).
Polarographic determination of tetra-ethyl lead in gasoline (D 1269-53 T).

Copies will be available later from ASTM at 1916 Race Street, Philadelphia 3, Pa, U.S.A. at a nominal charge of about 25 cents each.

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BRITISH OIL SEARCH

D'Arcy Exploration Company's exploratory well at Screveton, near Newark, ceased drilling at 3501 feet, no trace of oil having been found. The well at West Drayton, near Tuxford, had reached 1942 feet at the end of July and is to be carried to about 3500 feet.

A seismic survey, using the reflection method, is being undertaken over areas of about 30 sq. miles east of Nottingham and between Sutton and Tuxford, north of Nottingham.

CHEMICAL ENGINEERING

Part I—Introduction

By PROFESSOR F. H. GARNER, O.B.E.

The petroleum industry is mainly concerned with the provision of liquid fuels and lubricants for transport on land, sea, and in the air. The first world war stimulated a vast increase in the quantity of petrol required for road transport and for aviation petrol of high octane number for use in the air, and it was in the period 1918-22 that a rapid growth began in large scale refinery operation. These needs led to the use and development of the pipe still for petroleum distillation and in cracking operations, notably in the Dubbs and Cross plants, and to the discovery of tetra-ethyl lead.

As these processes were developed, more attention was paid to Chemical Engineering because of its importance in the operation and economics of large scale continuous processes, particularly as regards fluid flow, heat transfer, and distillation. Thus the development of the modern petroleum industry has been accompanied by the recognition of Chemical Engineering as an independent engineering science, with principles just as fundamental and worthy of study as those of any of the branches of pure or applied science. Much important progress in chemical engineering has been stimulated by the needs of, and due to efforts by, the petroleum industry.

Chemical Engineering is more dependent on "classical" physics—the properties of liquids, solids, and gases—than is any other branch of engineering; but it is also concerned with the thermodynamics and kinetics of reactions, the chemistry of the processes, and the mechanism of chemical reactions. Certain aspects of "classical" physics are now studied more intensively by physical chemists than by physicists, especially those processes concerned with changes of state as the transition from liquid or solid to gas or with diffusion processes. The approach of the chemical engineer to such problems is thus largely based on physical chemistry rather than on physics.

The chemist in the laboratory is concerned mainly with pure reagents, with operations conducted in glass vessels and with small quantities; so that reactions can be readily controlled by water cooling or by simple forms of heating. The chemical engineer, on the other hand, has to handle crude or relatively impure material in steel vessels and hence, in addition to corrosion problems, also is concerned with instrumentation in order to follow the course of a reaction. Since he may be working with relatively large quantities of material, the question of temperature control is of great importance and this, combined with the necessity of controlling compositions, pressure, and liquid and solid levels in vessels, has caused the development of instruments for the control of chemical operations; instrumentation and control has thus become of great concern to the chemical engineer. This is particularly so because of the necessity to develop operations in a continuous, rather than in a batch system.

All petroleum refinery processes can be considered as including a series of unit operations, thus, for example, the most important unit operations in the petroleum distillation plant are the flow of fluids, transfer of heat by conduction, convection and radiation, and distillation. Whilst it is convenient to separate processes as a series of unit operations, it must be emphasized that such unit operations depend on the same fundamental principles; thus mass

transfer from bubbles or droplets is involved not only in distillation and in fractionation, but also in all forms of liquid-liquid and liquid-gas contacting as, for example, in absorption of hydrogen sulphide from gases, in solvent refining by means of phenol or furfural, or in adsorption operations such as the removal of oil from spent clays.

In this series of articles the various unit operations are described briefly. There is however a list of references as a basis for further study. The unit operations described here are as follows: Fluid flow; heat transfer; distillation; absorption; adsorption; solvent refining including dewaxing; filtration. All these operations are of major importance in the petroleum industry. Their treatment here is of necessity elementary, and includes only the minimum equations to give a broad outline of the subject.

Part II—Fluid Flow

By D. C. FRESHWATER

In petroleum refining fluid flow is of outstanding importance since, apart from its obvious applications in the transport of crude petroleum, gases, and liquid products, it plays an important part in most other refinery processes, particularly distillation, cracking, solvent refining, adsorption, and filtration.

Fluids, both gases and liquids, are characterized by a great ease of handling, metering, and control, so that solids may be either liquefied, or suspended in gas or liquid so as to simulate the preferred state of fluidity.

It is important therefore for the chemical engineer to understand the laws governing the flow of fluids and also to appreciate the special characteristics of equipment for handling fluids. Fluids may be either liquids which are virtually incompressible and which can have very high viscosities like lubricating oil, or gases which are easily compressible and have very low viscosities such as methane. Clearly the type of equipment for transferring fluids from one part of the process to another varies widely with the material being handled. However, the laws of fluid flow may apply through the whole range.

Consider now the steady flow of fluid from a point A to a point B. Energy is required to keep the fluid moving, since it has to overcome frictional resistance in the connecting pipes. If A is higher than B then the extra potential energy of the fluid at A is normally sufficient to overcome the frictional resistance, but if B is at the higher level then not only must energy be supplied to overcome friction but also to raise the fluid through the difference in height between A and B. This energy is the external work put into the system by a pump. In addition to its potential energy, the fluid possesses energy due to a mass being in motion, that is kinetic energy, and also pressure energy. We can now write down an energy balance for steady flow conditions between points A and B. Energy entering at A + energy added by pump = energy leaving at B + energy lost in overcoming friction. This simple but important relationship is known as Bernoulli's theorem and finds wide application in fluid flow problems. It may be expressed mathematically in ft/lb units for incompressible fluids, i.e. normal liquids, as follows:

$$X_A + p_A V_A + \frac{u_A^2}{2g} + W = X_B + p_B V_B + \frac{u_B^2}{2g} + F$$

where X is the height in ft above a given datum; p is the pressure of the fluid in lb/ft^2; V is the specific volume of the fluid in ft^2/lb; u is the velocity of the fluid in ft/sec; W is the work supplied externally in ft/unit mass of fluid; and

F is the total frictional force in ft. The subscripts A and B are indications of conditions at points A and B. The term pV is the pressure energy of the fluid which may alter due to changes in specific volume, i.e. temperature changes, in the system.

For compressible fluids, i.e. gases, it is necessary to introduce another term to allow for the work done in expansion or compression through the system, but for a detailed treatment of this the reader is referred to one of the standard texts mentioned at the end of this article.

Measurement of Flow

The complete energy balance can be used to determine the power required to overcome all resistance to flow in pipes (except those directly due to friction). Conversely, by measuring the resistance to flow through a section of pipe the rate of flow may be determined by substitution in this equation, and this is the basis of practically all devices used for measuring the rates of flow of fluids, such as orifice meters, venturis, pitot tubes, and the like.

Consider, for example, the flow of water through a horizontal venturi meter, $x_A = x_B$. Since water is virtually incompressible and there is no temperature change $V_A = V_B$. Hence, since no external work is put into the system, i.e. $W = O$, it is clear from Bernoulli's theorem that the pressure drop across the inlet and throat of the venturi, $p_A - p_B$ is equal to $\frac{u_B^2 - u_A^2}{2g}$. Since the cross-sectional areas at the inlet and throat are known, the water velocity and hence the rate of flow can be determined simply by a pressure drop measurement.

Frictional Resistance

One of the most common and important problems in fluid flow is the determination of the frictional resistance in a piping system. For a given arrangement of pipe-work one would expect the frictional resistance to increase as the rate of flow of fluid through the pipe increases, and in general this is found to be so. However, the resistance (often termed simply "pressure drop" because for a constant diameter of level pipe the velocity is constant and hence the loss in energy shows only as a change in pressure) does not increase uniformly with increase in flow, except at low velocities.

A plot of pressure drop against flow rate shows a straight line section from zero velocity, but at some low velocity there is a transition from this linear characteristic, to a curve when the pressure drop becomes directly proportional to the square of the flow rate. This indicates that at different velocities, different types of flow in closed pipes exist, one type at low velocities and one at higher velocities. A classical experiment due to Osborne Reynolds many years ago shows these differences very clearly. By means of the apparatus shown in Fig. 1, a fine jet of coloured ink is continuously injected into a glass tube through which water is flowing at a controlled rate.

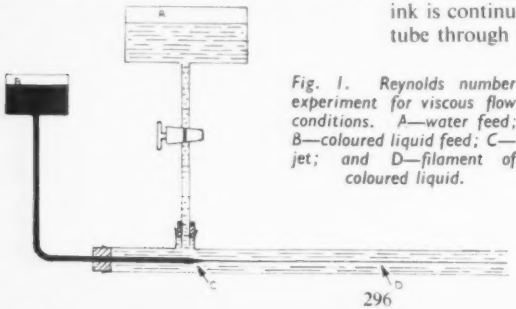

Fig. 1. Reynolds number experiment for viscous flow conditions. A—water feed; B—coloured liquid feed; C—jet; and D—filament of coloured liquid.

At low water velocities, the jet of coloured ink maintains itself as a filament along the whole length of the tube. This phenomena persists even when the jet is off centre, and if more than one jet is

injected then the several threads of colour run parallel along the tube. Clearly at these low velocities the water flows through the tubes in layers without mixing. However as the velocity of the water is increased by increasing the flow rate a critical speed is reached at which this flow mechanism breaks down. The coloured thread disappears and the colour is dispersed evenly through the whole of the water, showing that mixing is occurring. Measurements show that the critical velocity also corresponds to that at which the pressure drop relationship changes. The type of flow which exists at low velocities is known as streamline or viscous flow; that at higher velocities is called turbulent flow.

Before pressure drop calculations can be made the type of flow which exists under the conditions of a given problem must be determined. In general, with otherwise constant conditions, the type of flow changes as the velocity increases. Reynolds discovered that the change or critical point also depends on the pipe diameter D, the density of the fluid ρ, and its viscosity μ. These three variables together with the velocity of the fluid when combined in one way form a dimensionless ratio which characterizes the type of flow. This ratio, known as the Reynolds' number, is expressed as

$$\frac{Du\,\rho,}{\mu}$$

where all the values are in the same system of units.

When the Reynolds' number (usually abbreviated to *Re*) is less than about 2100 the flow is viscous.

For viscous flow the friction loss is directly proportional to the viscosity, velocity, and density of the fluid; and inversely proportional to the pipe diameter, hence the straightline relationship between pressure drop and flow rate at low velocities. The exact relationship for the loss of head in F.P.S. units is:

$$H_F = \frac{32Lu\mu}{gD^2}$$

where H_F = loss of head due to friction; L = length of pipe; g = acceleration due to gravity; and the other symbols have the same significance as before.

When the Reynolds' number is over 2100, the flow is usually turbulent and it is found that the loss of head due to friction is:

$$H_f = \frac{Lu^2\,4f}{2gD}$$

where f is called the friction factor and is a unique function of the Reynolds' number. When f is plotted logarithmically against the Reynolds' number $\frac{Du\rho}{\mu}$ a straight line is obtained, thus illustrating the fundamental soundness of the relations between the variables represented above.

In addition to determining the friction loss through straight pipes, the loss through fittings, and changes of cross-section must be determined. The latter are found by an application of Bernoulli's theorem and the former from experimental results on similar fittings. The sum of the various resistances then determines the total resistance to fluid flow.

Fluid Flow and Pumps

The chemical engineer has to consider how to supply the energy necessary to overcome the total resistance to fluid flow. The energy for the movement of liquids is supplied by pumps which are classified as reciprocating, rotary, or centrifugal.

Reciprocating pumps, of necessity, give pulsating flows. They can handle a wide range of liquids and can give very large hydraulic heads. The quantity of fluid pumped is controlled by varying the length, or (more usually) the speed of stroke. In general, reciprocating pumps are simple to operate and easy to maintain in use.

Rotary pumps can be used for most

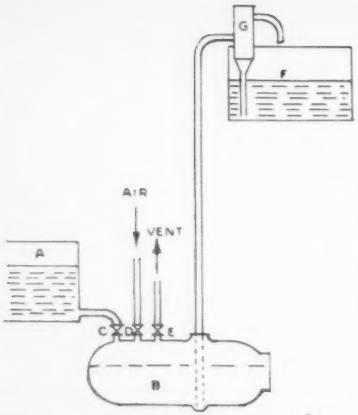

Fig. 2. Air-operated acid egg. Egg B is filled from feed tank A by opening inlet valve C and air vent E. When B is full, C and E are closed and valve D opened. Air pressure forces acid out of B into receiver F until B is empty. Any air blown up the outlet pipe passes through separator G to remove spray.

liquids, but find particular application for pumping highly viscous liquids. They produce reasonably high heads and give a constant discharge pressure. Such pumps are usually operated at constant speed and controlled by a by-pass on the outlet side. There is a vast number of different designs of rotary pumps.

Centrifugal pumps can be used for very many types of liquids including liquids having solid particles in suspension. They can produce high heads and give a constant discharge pressure. The usual method of control is by means of a valve on the outlet side of the pump.

There are other methods of moving liquids such as the gas-operated acid egg (Fig. 2) and the gas-operated "air-lift" (Fig. 3).

Gases. For the movement of gases, ejectors, compressors (reciprocating), fans, and blowers are used.

Ejectors move gases at low pressures by transferring the kinetic energy of a moving fluid (usually high pressure steam or water) to the gas to be moved. They only develop discharge pressures a few inches above atmospheric pressure but are simple and cheap, and operate for long periods of time without attention (Fig. 4).

Compressors (*reciprocating*) are used where a high discharge pressure is required. Since gases are highly compressible the term which allows for this in Bernoulli's equation is appreciable and the work done on the gas is transformed to pressure head, but is accompanied by a considerable temperature rise, and hence most compressors have some cooling device fitted.

Fans are the most common device for moving gases. They are relatively cheap but have a rather low efficiency and only develop low discharge pressures of a few inches of water.

Blowers are somewhat similar to rotary pumps. They give intermediate pressures between the usual limit of the fan of 1·0 p.s.i. gauge and the lower economic limit of the compressor of about 10 p.s.i. gauge (Fig. 5).

Valves. An important, but often neglected aspect of fluid flow in practice

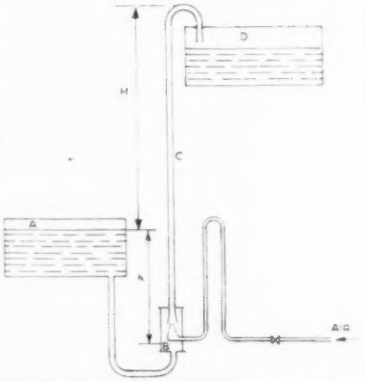

Fig. 3. Air lift. Liquid from tank A flows by gravity into the "foot" B, where a stream of air bubbles is introduced. This fills the lift pipe C with a mixture of liquid and air of total height H+h. Since this weighs less than a column of liquid of height h the mixture flows up pipe C and is discharged into D.

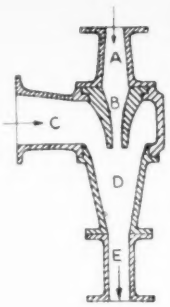

Fig. 4. Steam jet injector. High-pressure steam enters at A and expands through nozzle B leaving at a very high velocity. Non-condensible gases from a low-pressure system enter at C and these are picked up by the jet of steam in the throat of the venturi D. The gases are compressed and the steam-gas mixture discharged through E.

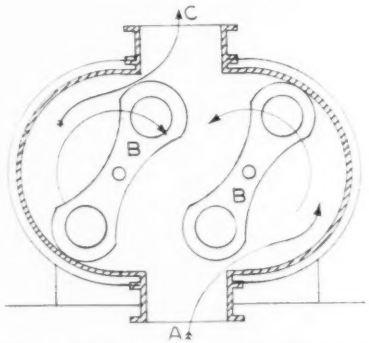

Fig. 5. Rotary blower. Gas enters at A, is compressed by rotating paddles B, and discharged at C.

is the selection of correct valve types. The usual practice is to install cocks on all process lines except where the rate of flow is to be controlled by the throttling action of a valve. On the other hand, water and steam lines are usually fitted with globe type valves for small lines and gate valves for the larger ones. Air service lines are often controlled by means of diaphragm type valves.

For further reading, reference may be made to the following:

Elements of Chemical Engineering, 2nd Ed. Badger & McCabe. McGraw-Hill Publishing Co.

Chemical Engineering Unit Operations. Rumford. 1951 (Constable & Co.).

Selection of Pump. Dolman. Chem. Eng. 59(3), 1952.

PERSIAN GULF EXPLORATION

D'Arcy Exploration Co. announce that they have acquired two concessions as follows:—(1) For 65 years from March 1953, over the continental shelf area, subject to the ruler of Abu Dhabi. The area exceeds 12,000 sq. miles, and (2) also over the continental shelf area, subject to the ruler of Dubai, covering 1300 sq. miles. This holding is in conjunction with Compagnie Française des Pètroles for 60 years from August 1952.

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PETROLEUM MEASUREMENT TABLES

The National Bureau of Standards, U.S. Department of Commerce, announces that NBS Circular 410, *National Standard Petroleum Oil Tables*, and its *Supplement* will be withdrawn from circulation 1 January 1954. The information given in Circular 410 has now been incorporated in the *ASTM-IP Petroleum Measurement Tables*, recently issued by the American Society for Testing Materials and the Institute of Petroleum. Copies of the British edition of new tables are available from the Institute, price £2 10s. post free.

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U.K. PETROLEUM CHEMICALS

The full report of the joint meeting of the London Section of the Society of Chemical Industry and the Institute of Petroleum, which was held on 2 March 1953, has now been published as a special supplement to "Chemistry and Industry". The supplement contains all the papers and the full discussion, and copies can be obtained from Mr Blanchard, Despatch Department, Conjoint Chemical Office, 9-10 Savile Row, London, W.1. The price of the supplement is 15s, or a special price of 4s 6d per copy to those members of the Institute of Petroleum who registered as participants in the meeting.

THE LOYAL ADDRESS

The President of the Institute has received the following letter from the Secretary of State for Home Affairs:

Sir,

I have had the honour to lay before The Queen the Loyal and Dutiful Address of the President, Council and Members of the Institute of Petroleum on the occasion of Her Majesty's Coronation, and I have it in Command from The Queen to convey to you Her Majesty's warm thanks for the expressions of loyalty and devotion which it contains.

I am,
Sir,
Your obedient Servant,

(Signed) DAVID MAXWELL FYFE.

The President,
Institute of Petroleum.

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PERSONAL NOTES

Dr Gustav Egloff, F.Inst.Pet., has been appointed a member of the Washington Award Commission of the Western Society of Engineers, 1953-56; a national director of the Armed Forces Chemical Association, 1953-54; and a member of the Advisory Committee, Midwest Chapter, of the Association 1953-54.

Air Commodore F. R. Banks, C.B., O.B.E., F.Inst.Pet., was at the A.G.M. re-elected a vice-president of the British Internal Combustion Engine Research Association.

W. K. Dykes, M.Inst.Pet., has recently returned to the U.K. after 14 years in Trinidad as chemist-in-charge of the Inspection Laboratory of Trinidad Leaseholds Ltd.

Leslie C. Beard, Jr., was recently elected president of Socony-Vacuum Laboratories, New York, for 1953-54.

V. C. Beaumont was recently presented with a gold watch and a canteen of cutlery on the completion of 40 years' service with the Vacuum Oil Co.

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SAFETY ON THE ROADS

An excellent contribution to the cause of safety on the roads is the release in the U.K. by the Vacuum Oil Company Ltd. of the film "And Then There Were Four".

In this film the subject of safety is dealt with from the angle of those at home waiting for the return of husband, or wife, or child. Stress is laid on the effect of the minor disregard of traffic regulations as being a far greater cause of accidents than the taking of alcohol by drivers, and good can only result from the widest possible distribution of this film throughout the country. In order that this wide distribution may be achieved, the film has been made available to the Royal Society for the Prevention of Accidents, and 16 mm copies may be obtained on loan on application to G. A. Nurse, Manager of the Film Library, at 17 Knightsbridge, S.W.1. Running time is about thirty minutes.

WPC PERMANENT COUNCIL MEETS

The Permanent Council of the World Petroleum Congress met recently in London to discuss matters relating to the Fourth Congress in 1955 in Italy, and the opportunity was taken for them to meet leaders of the British petroleum industry. Seen above are (1) E. V. Murphree (chairman of the Council) with H. S. Gibson, C.B.E. (president of the IP); (2) E. LeQ Herbert with Prof J. N. J. Perquin; (3) T. Dewhurst and R. Navarre; (4) S. Scheer, J. Beukers, Dr E. B. Evans and H. S. Gibson; (5) Col S. J. M. Auld, O.B.E., M.C., with Prof and Mrs F. P. Malschaert; (6) C. A. P. Southwell, C.B.E., M.C., and Prof H. Weiss; (7) R. Navarre, A. J. Ruthven-Murray, G. W. Dunkley, O.B.E., and Prof C. Padovani; (8) D. A. Hough (General Secretary), J. A. Beukers, and S. Scheer.

AROUND THE BRANCHES

FAWLEY, LONDON, NORTHERN, PERSIAN GULF, SCOTTISH, SOUTH EASTERN, SOUTH WALES, STANLOW, TRINIDAD

Persian Gulf Branch

The 14th ordinary general meeting of the Bahrein Sub-area of Persian Gulf Branch was held on 21 June 1953, in the assembly room of the Bahrein Petroleum Company's school. The principal part of the meeting was the presentation of a film portraying the use and benefits of scratchers and centralizers in oilwell cementing operations.

R. Godfrey, chairman of the Bahrein Sub-area and manager of the Producing Department of the Bahrein Petroleum Company, prefaced the film by giving a brief account of the fundamentals involved. The details of the functioning of reversible scratchers and spiral centralizers were shown in the film by means of animated cartoons. After the film, Mr Godfrey described in detail the many causes of failure of cementing jobs.

Subsequently the meeting was thrown open for any questions. There ensued a most interesting half-hour during which members of the Producing Departments of both the Bahrein Petroleum Company and Petroleum Concessions (Qatar) Ltd. discussed their own experiences concerning oilwell cementing.

South-eastern Branch

On Saturday 27 June 1953, 40 members of the branch went by coach to the Vacuum Oil Company's new refinery at Coryton.

The group were received by D. P. Parker, the project manager, and other senior engineers among whom were Messrs Kennaby, Kohring, Dodge, and Jamison.

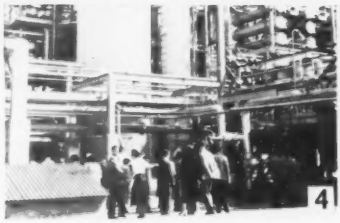
The party was first taken to the lecture room, where there was a large coloured map of the refinery. Mr. Kennaby gave a brief description of the Company's operations.

The party was then taken around the refinery in two groups by expert guides, after which they were taken to the Vacuum Oil Company's institute, where a most generous lunch was provided.

After lunch Mr. Parker said that he did not intend to make a speech, but in welcoming members of the South-eastern Branch of the Institute of Petroleum, he was aware that it was not often that they were able to welcome an organization younger than their own, work on their new refinery having been commenced in 1950. It was hoped that the party had enjoyed their visit, and found interest in the various plants under construction and in operation. Mr Parker went on to say that, as could be seen, the major part of the installation was new, with the exception of certain parts of the tank farm area. When the visit had first been planned the Company had known that the whole of the plant would not be in operation, but they had felt that the general pattern of things to come would be of interest. He hoped the party would have questions to ask, which he and his colleagues would try to answer, and he felt sure that many would want to know why they had done things in certain ways which might differ from those of other refineries.

Mr Parker also mentioned that the building in which they were lunching was unique, inasmuch as it was both consecrated and licensed. It was built in 1903 and had been used for various social functions for munition workers, then for the Cory Institute, and it was now used for the social activities of the Company's staff.

N. W. Grey, chairman of the Branch, in replying to Mr Parker said that he spoke on behalf of the Branch members when he thanked Mr Parker and his assistants, and the refinery manager, D M. Glendinning, for the most courteous and generous manner in



LONDON BRANCH VISIT TO KENT REFINERY

In the August issue an account was given of the London Branch visit to the Kent Oil Refinery. The above photographs were taken during the journey and at the refinery and show (1) the start of the trip at exactly 10.30 am; (2) well on the way; (3) a study at the bar—A. F. Fulford wonders whether to have another, P. D. Gibson soliloquizes over a glass of ale, while another member searches for Father Thames' daughter; (4) great interest being displayed in the refinery plant.

which they had received the members of the South-eastern Branch.

Mr Grey went on to say that apart from the refinery operations, about which one can always learn something, he had learnt two things. The first was at the bar, when being offered refreshment by Mr. Kennaby he had doubted whether there was time, and Mr Kennaby had replied that "Time was made for slaves". The second thing was the information given by Mr Jamison that the Vacuum Oil Company had two distinct temporary offices, one for the junior engineers and one for the experienced plant operators, and that they had found, on pulling down the dividing wall, that the barrier had been removed both physically and metaphorically, inasmuch as the engineers intermingled freely with the operators, the junior engineers learning much from the experienced operators and the experienced operators delving into theoretical problems; thus practice and theory had been combined, which Mr Grey said he considered was of the utmost importance.

In conclusion, Mr Grey thanked them all for giving up the whole of their Saturday, and hoped that the Branch would be given a chance to reciprocate their hospitality at some future date.

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BSI at New Address. On 17 August the British Standards Institution was in full operation at its new premises at 2 Park Street, London, W.1. (Phone: MAYfair 9000), where its previously scattered departments are under one roof.

ABCM. The telephone number of the Association of British Chemical Manufacturers has been changed to HYDe Park 4126-7, 1557-8.

Canadian Fina Refineries Ltd., a new $25 million associate company of Canadian Fina Oil Ltd., announce that they will shortly start construction of a refinery in the province of Quebec for the production of motor spirit and lubricating oils.

PAKISTAN OIL SEARCH

The search for oil in the Zin mountain of the Bugti tribal territory began on 17 July, when His Excellency Ghulam Mohammad, the Governor-General of Pakistan performed the formal spudding-in ceremony of the first test well of Pakistan Petroleum Ltd. in this area.

Replying to the address of welcome from M. J. Condon, chairman of the prospecting Company, His Excellency the Governor-General said "I have heard with much interest the brief but illuminating narrative of the events that have led your Company up to where it stands today in its exploratory activities in this area, and I am confident that it is the prelude to an important chapter that will be added in due course to the history of the search for oil in Pakistan. An idea of the scale on which it is proceeding can be gathered from the fact that 34 oil-mining concessions have been granted since the enforcement of the Pakistan Petroleum (Production) Rules, 1949. Of these, 22 were granted to Pakiston Petroleum Ltd. and ten to Pakistan Oilfields Ltd., ten of the former being over areas in East Pakistan. Both these Companies have greatly intensified their exploratory efforts during the last few years. To mention the latest figures only, the year ending 31 December 1952 saw the spudding-in of eight test wells, of which two, the credit for which goes to Pakistan Petroleum Ltd., proved successful. One of these two wells was the second Sui well, and it proved that the natural gas struck in the course of drilling the first Sui well was extensive enough to admit of commerical utilization. The Company have furnished Government with a report on the utilization of this gas, and the report is under the active consideration of Government . . ."

Concluding his reply to the address of welcome the Governor-General, while congratulating the Company officials, expressed the hope that the project initiated by the ceremony would prove an even greater success and said "I have great pleasure in declaring the Zin oil test well open and wishing it God-speed." His Excellency then performed the opening ceremony by cutting a green ribbon wound round the "kelley", allowing it to be rotated and lowered. After the ceremony His Excellency visited the mosque and saw amenities provided for the staff.

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CRUDE OIL PRODUCTION

	1953	
	June Tons	*Jan-June Tons*
Iraq Petroleum Co. (Kirkuk)	1,935,420	10,986,662
Basrah Petroleum Co. (Zubair)	232,572	1,457,260
Mosul Petroleum Co. (Ain Zalah)	111,519	675,884
Qatar Petroleum Co. . .	349,128	1,946,366
Kuwait Oil Co. . . .	3,684,975	20,589,588

With a total of 13,119,806 tons for the first half of 1953 the production from Iraq is 87·4 per cent higher than the corresponding period of 1952, when the total was 7,001,802 tons.

For Kuwait the half-year total was 12·8 per cent higher than the 18,255,018 tons produced in the first six months of 1952.

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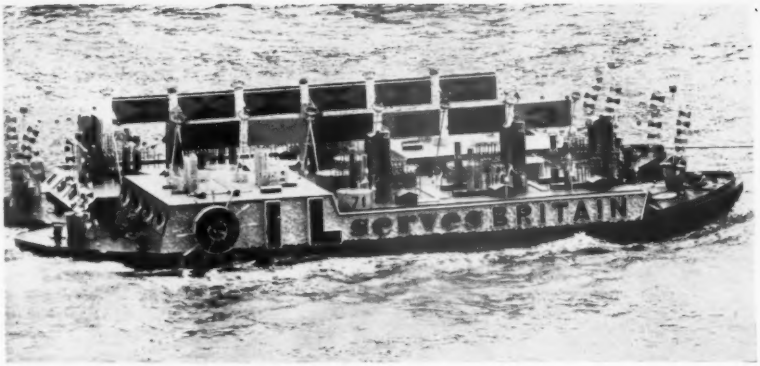
M.E. CRUDE PRICES

Anglo-Iranian Oil Co. posted export prices, effective from 16 July 1953, are:

	Per brl $
Kuwait (fob Mina-al-Ahmadi) 31-31·9° API	1·72
Iraq:	
Persian Gulf (fob Fao) 36-36·9° API	1·92
Eastern Mediterranean (fob Tripoli or Banias) 36-36·9° API . .	2·39
Qatar (fob Umm Said) 40-40·9° API	2·08



An Anglo-Iranian photograph

ROYAL RIVER PAGEANT, 1953

The growth of petroleum refining in the U.K. between 1938 and 1953 was featured on the oil industry's exhibit shown above. On each side of the central motif were model refineries scaled to show comparative capacities for the two years.

U.K. DEFENCE SPECIFICATIONS

Among the new Defence Specifications issued by the Joint Petroleum Products Standardization Committee and the Paints Sub-Committee are:

DEF/1041. **Paint, finishing, for the exterior of jerricans.** Protective coating for jerricans and small petrol tanks. (Superseding C.S. 1864.)

DEF/1042. **(1) Paint, finishing for the exterior of jerricans, stoving** and **(2) Paint, concentrated, finishing, for the exterior of jerricans, stoving, dipping, and flow-coating.** As DEF/1041, stoving variety. Superseding C.S. 2688.)

DEF/1043. **Paint, finishing, for the interior of bulk petrol tanks.** Protective coating for interior surfaces of tanks and containers for storage and transfer of petrol in bulk. Suitable for two-coat system. (Superseding C.S. 2350.)

DEF/2001. **Oil OM-13.** One grade for temperate and moderately cold conditions as a buffer oil and hydraulic fluid in gunnery equipment, and in shock absorbers of vehicles having synthetic rubber glands; also for lubrication, by spray or other means, of fire control instruments, such as fuse-keeping and fire control clocks. (Superseding C.S. 1117.)

DEF/2002. **Oil OM-21.** One grade for high-speed shafting and machine spindles, small electric motors, sewing machines, and such like; as a light cutting and quenching oil; and for flushing the oil systems of piston engines and gear-boxes. (Superseding C.S. 1436.)

DEF/2101. **Oil OMD-60, -110, and -330.** Three grades of lubricants for the compression ignition and spark ignition engines of ground equipment operated by the Services. (Superseding C.S. 2463.)

DEF/2221. **Grease LG-380.** General purpose lubricant (including the lubrication of chassis and of low-speed ball bearings) in cold climates. (Superseding C.S. 2623.)

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Universal-Matthey Products Ltd. Incorporated on 9 July this is a joint subsidiary of Johnson Matthey and Co. Ltd. and Universal Oil Products Co. for the manufacture of UOP platforming catalyst. Construction is to begin immediately on a manufacturing plant in England and output is expected in mid-1954.

Fork Trucks. An interesting demonstration of fork trucks was recently staged in London by Conveyancer Fork Trucks Ltd. of Warrington. Three models were shown in operation: the FTC-4, a flameproofed diesel-driven model; the E4-20, electric driven; and the E2-20, electric driven. For the demonstration, oil drums were used and the facility with which these were moved was marked, particularly when the special drum clamp was used to lift four drums placed in a vertical position.

COURSES IN PETROLEUM TECHNOLOGY

The 1953-54 course of lectures on the general technology of petroleum commences at the Sir John Cass College (Jewry Street, Aldgate, London, E.C.3.) at 3.30 p.m. on 1 October and continues on Thursday afternoons until 18 March. There will also be visits to refineries and installations at Fawley, Shell Haven, and Llandarcy.

There will be 20 lectures in all, the subjects being:—

Introduction. Origin of petroleum and types of hydrocarbon. Types of products. 1 Oct.
Discovery and production. 8 Oct.
Distillation and fractionation. 15 Oct.
Combustion. Uses and properties of gases and natural gasoline. 22 Oct.
Principle of spark ignition engine. Knocking and its measurement. 29 Oct.
Testing of gasoline. 5 Nov.
Production of gasoline. 12 Nov.
Uses, testing, and manufacture of kerosines and S.B.P. spirits. 19 Nov.
Principle of C.I. engine and its fuel requirements. 26 Nov.
Fuel oils and their applications. 7 Jan.
Applications of bituminous products, testing, and manufacture. 14 Jan.
Function and applications of lubricants. 21 Jan. Testing and manufacture of lubricants. 28 Jan.
Development of lubricants. 4 Feb.
Application, testing, and manufacture of greases. 11 Feb.
Paraffin wax refining and applications. 18 Feb.
Special products. Chemicals. 25 Feb.
Bulk oil storage. 4 March.
Measurement and transport. 11 March.
Research and development. 18 March.

Lecturers are E. J. Boorman, B.Sc., Ph.D., D.I.C., P. F. Ellis, B.Sc., and L. W. G. Firmin, B.Sc. Fee for the course is 30s and enrolment forms are obtainable from the Principal of the College.

Chemicals from Petroleum

Commencing on 15 October at 6.30 p.m. and continuing on Thursdays until 3 December, the Sir John Cass College has a course of 8 lectures on chemicals from petroleum as follows:—

History and development. J. A. Oriel, C.B.E., M.C., M.A.
Basic raw materials. S. F. Birch, Ph.D., B.Sc.
Petroleum chemical developments. M. A. Matthews, D.Sc., Ph.D.
Plant for synthetic detergents. J. L. Edgar, B.Sc., Ph.D., A.R.C.S., D.I.C.
Plant for chemical solvents. W. L. Wood, M.Sc.(Tech.), Ph.D.
Chemicals for the oil industry. F. Mackley, B.Sc.
Plastics and man-made fibres. V. E. Yarsley, M.Sc., D.Sc.
Economics and trends. R. F. Goldstein, B.Sc., Ph.D

Course fee is £1 and application forms are available from the College.

Oils, Fats, and Waxes

A course of 12 lectures on the recent Chemistry of oils, fats, and waxes is being held at Acton Technical College, London, W.3., at 7.30 p.m. on Fridays, commencing on 25 September. The subjects will include auto-oxidation of fatty acids and esters, analysis of oils and fats, including spectroscopic methods, and analysis of waxes.

Fee for the course is 30s and application forms are available from the Principal, Acton Technical College, High Street, Acton, W.3.

Instrumentation and Control

Eleven lectures and demonstrations on industrial instrumentation and automatic process control open at the Battersea Polytechnic on 1 October. The course will cover temperature, pressure, level, flow, and valve sizing, the fee being £1 7s 6d. Enrolment forms are available from Battersea Polytechnic, Battersea Park Road, S.W.11.

Feed-Back Control

Commencing on 5 October at 7 p.m. at the Battersea Polytechnic is a course of ten lectures on the mathematics of feed-back control. Fee is £1 5s and enrolment forms are available.

Conductivity, pH, Viscosity, Humidity

Two-lecture courses on the measurement and control of conductivity (25 Jan., 1 Feb.) of *p*H (8 and 15 Feb.), of viscosity (22 Feb., 1 March), and of humidity (8 and 15 March) are being held at Battersea Polytechnic. Fee is 5s per course.

FORTHCOMING MEETINGS

The Institute

The Friction of Solids. F. P. Bowden, Sc.D., F.R.S. (*University of Cambridge*). Redwood Lecture. At 26 Portland Place, London, W.1., 5.30 p.m. (*tea, 5 p.m.*), **14 October.**

Paint in the Petroleum Industry. H. B. Footner, B.Sc., Ph.D., (*The Shell Petroleum Co., Ltd.*). At 26 Portland Place, London, W.1., 5.30 p.m. (*tea 5 p.m.*), **11 November.**

Stanlow Branch

Retail Marketing of Motor Spirit and Lubricants in the U.K. J. R. Higdon, Assoc.I.M.I. At Arcadian Restaurant, Morecambe, 8.30 p.m., **2 October.**

Discovery and Development of an Oilfield. H. R. Lovely, A.R.S.M., F.G.S. At Grosvenor Hotel, Chester, 7.30 p.m., **21 October.**

Fawley Branch

Supper-Dance. At Esso Recreation Club, Holbury, 7.30 p.m.

Distribution of World Oil Reserves. G. M. Lees, M.C., D.F.C., Ph.D., F.R.S. At Esso Recreation Club, Holbury, 7.30 p.m., **16 October.**

London Branch

Lubrication—Chemist or Engineer. E. A. Evans, M.I.Mech.E., F.R.I.C. At 26 Portland Place, London, W.1., 6.0 p.m. (*tea*, 5.30 *p.m.*). **22 September.**

★ ★ ★

CBMPE LUNCH

The Minister of Fuel and Power, the Rt. Hon. Geoffrey Lloyd, P.C., M.P., provided his engagements permit, will be the guest of honour at the Council's tenth anniversary luncheon and AGM at the Dorchester Hotel on 15 October.

Careers in Chemical Engineering is the title of an attractive brochure, which gives a brief introduction to "the profession of chemical engineering and to the careers which it offers". Copies are obtainable, price 2s, post free, from The Institute of Chemical Engineering, 56 Victoria St., Westminster, London, S.W.1.

Polyester Handbook. This book is designed to be of practical help to the fabricator. It contains many useful hints and formulae which have not appeared elsewhere. Copies may be obtained from Scott Bader and Co. Ltd., 109 Kingsway, London, W.C.2.

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Vacuum Oil Company Limited, invites applications for the position of **Chemist** in their Laboratory at Coryton Refinery. Applicants should have B.Sc., A.R.I.C., or equivalent qualifications. Experience in an industrial laboratory, preferably in petroleum, would be an advantage, but is not essential. The Company would be interested to receive applications from men who have just completed their academic studies. The work involved comprises analytical testing, control of Refinery processes involved in the production of petroleum products and all the ancillary problems arising therefrom. Applications giving full details of qualifications and experience should be addressed to The Industrial Relations Superintendent, Vacuum Oil Company Limited, Coryton Refinery, Coryton, Essex, and clearly marked "L.Y.C."

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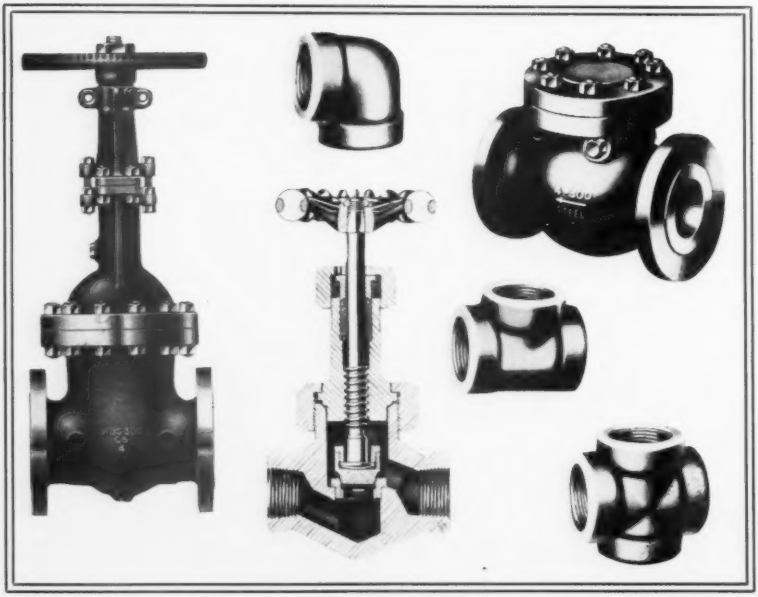

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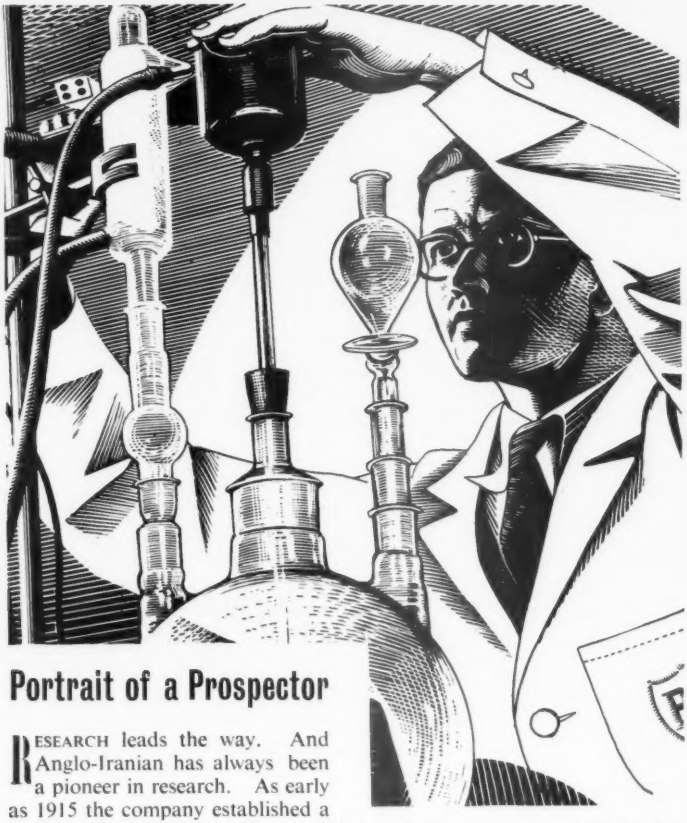

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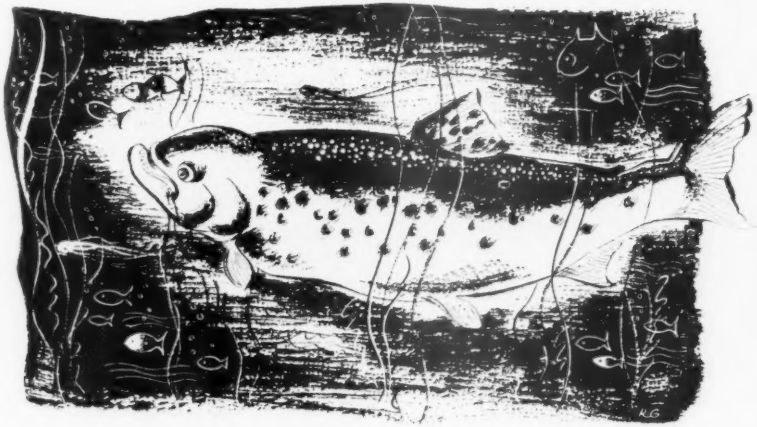

Old Cannibal

In his splendid silver youth he quivered on the fin in the quick-flowing shallows, or broke the surface after flies. Now in his black old age he lies in the deep hole under the bridge, killing the young fry, spoiling the fishing, hated by the angler. Catching him is a tricky problem, needing special skill and special equipment.

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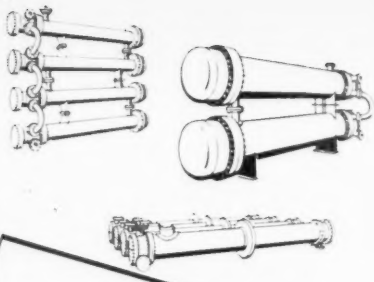

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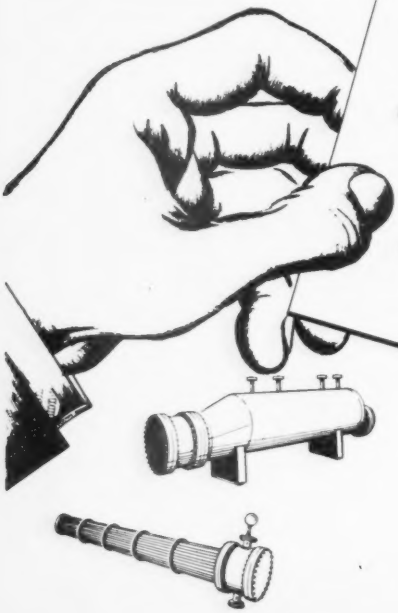

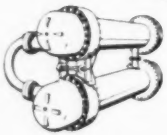

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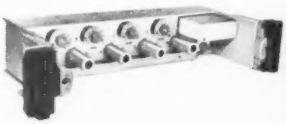

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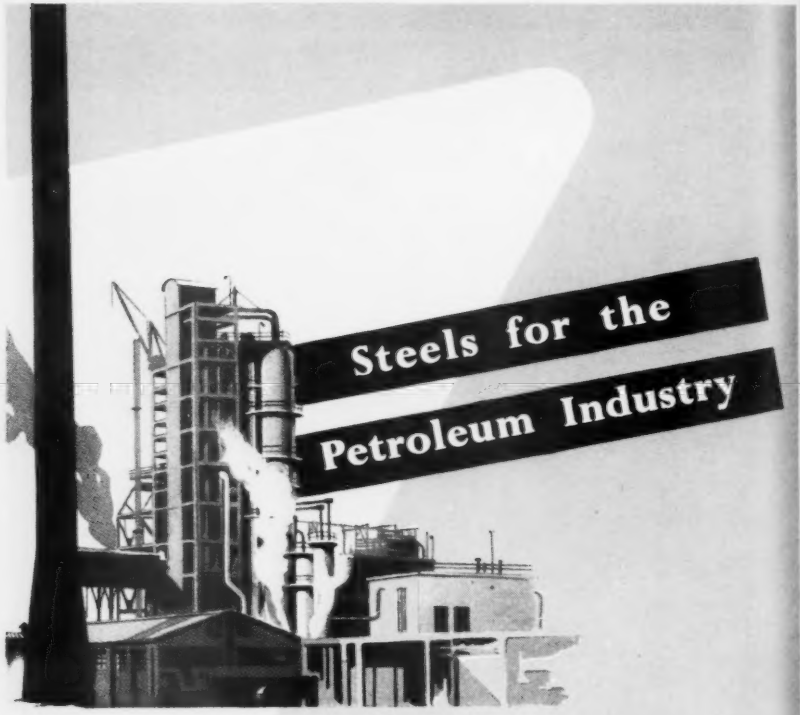

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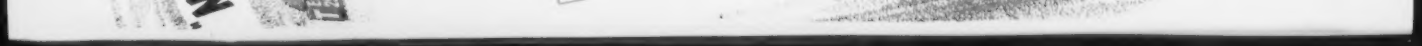

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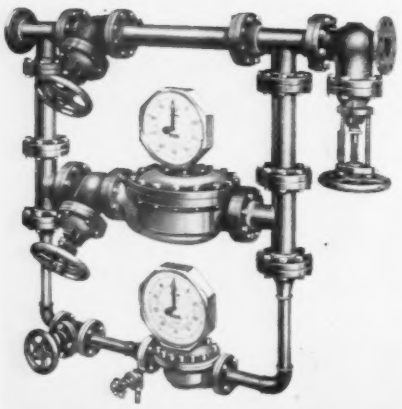

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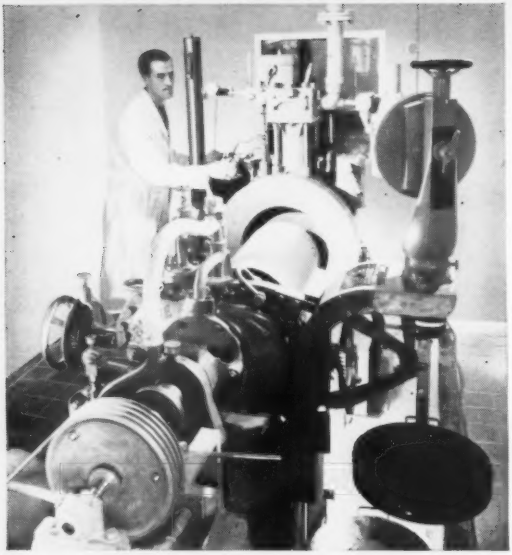

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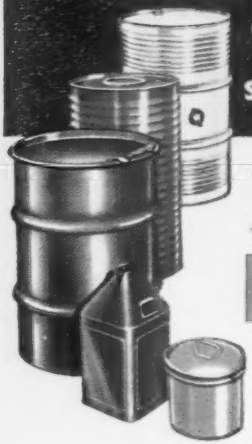

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